RESULTS

ERECT TREES CO[illegible] REMAINS

IN

COAL-FORMATIO[illegible] OTIA.

J. W. DAWS[illegible] LL.D.

From the PHILOSOPHICAL TRANSACTIONS OF T[illegible] CIETY.—Part II. 1882.

ON THE

RESULTS OF RECENT EXPLORATIONS

OF

ERECT TREES CONTAINING ANIMAL REMAINS

IN THE

COAL-FORMATION OF NOVA SCOTIA.

BY

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XII. *On the Results of Recent Explorations of Erect Trees containing Animal Remains in the Coal-formation of Nova Scotia.*

By J. W. Dawson, *LL.D., F.R.S., C.M.G.*

Received October 11, 1881,—Read January 12, 1882.

[Plates 39–47.]

The occurrence of remains of land animals in the interior of erect fossil trees is, so far as yet known, confined to certain horizons in the coal-field of the South Joggins in Nova Scotia. These remains were first discovered by Sir Charles Lyell and the writer in the summer of 1851. They were found in fragments of the sandstone filling an erect *Sigillaria* which had fallen from the cliff near Coal Mine Point. As other erect trees occurred in the beds from which this was supposed to have fallen, search was made by the writer in subsequent visits for additional trees; but up to 1876 only three of those which became accessible by the wasting of the beds were found to yield animal fossils. These, however, afforded many additional specimens, and several new species of Batrachians and Millipedes. The results of these explorations were published at various times in the Journal of the Geological Society of London,* in a work entitled 'Air-breathers of the Coal Period,' and in 'Acadian Geology;' and Dr. Scudder described the new species of Millipedes in the Memoirs of the Boston Society of Natural History.

The beds containing the productive trees being thus well known, and being exposed in a cliff and in a reef extending into the sea, it seemed probable that many others might be obtained by quarrying operations of no great difficulty. In 1878 the subject was brought under the notice of the Council of the Royal Society, and a grant of £50 was made from the Government Fund to aid in the extraction of these trees and the collection of their contents. With the aid of this grant, a thorough survey and examination has been made of the cliff and reef by Mr. Albert T. Hill, C.E., by Mr. W. B. Dawson, C.E., and by myself, with the kind aid of B. B. Barnhill, Esq., Superintendent of the Joggins Coal Mines. By these means, along with the removal of fallen débris and sand from the outcrop of the beds, twenty additional trees were discovered and were extracted by cutting and blasting; affording many additional

* Vols. x., xvi., xviii., xix.

specimens and much information respecting the conditions of accumulation of the beds and the manner of entombment of the animal remains.

Three annual reports have been made to the Society, detailing the plan and progress of the work. I may here merely state that, after preliminary clearing and exposure of the accessible trees, more especially in the reef extending from the shore and uncovered at low tide, the precise position of each was marked on the plan and section. The trees were then carefully taken out and their contents were examined. The portions containing animal remains were preserved in as large pieces as possible, and were boxed on the spot, the material of each tree being kept by itself. On being taken to Montreal, the whole of the material was cleaned and examined and carefully split up, each surface being scrutinised with the lens under a strong light. The fossils found were marked, keeping together the bones belonging to each skeleton, and were exposed as far as possible with fine chisels and needle points. As the work proceeded, drawings and photographs of the more important bones were made, more especially in the case of those which ran any risk of being damaged in the development of neighbouring or underlying fragments. The pieces belonging to each animal were then attached to cards or placed in separate drawers for study. This preliminary labour necessarily required much time, and though the accessible trees were exhausted in 1879, the final revision of the specimens and the microscopic examination of the bones and teeth have been completed only in the present year.

I may add that, unless additional specimens are exposed by falls of the cliff, further material of this kind can be obtained only by mining in the 6-inch coal supporting the trees, and its roof.

In the following pages I propose to notice as shortly as is consistent with clearness, the new facts obtained from the study of these interesting fossils, under the following heads:—

1. Geological relations of the beds containing the fossiliferous trees.
2. Character and contents of the trees
3. Description of the included animal remains.

1. Geological Relations of the Beds.

The beds in question belong to Group XV. of Division 4 of the section of the South Joggins, tabulated by Sir W. E. Logan and the writer.* The detailed sequence of the beds more immediately connected with the fossiliferous trees, as noted in the course of the recent explorations, is as follows, in descending order; the dip of the beds being S. 30° W., at an angle of 32°.

* 'Acadian Geology,' pp. 156 to 192.

	Ft.	ins.
1. *Gray sandstone*, massive, constituting the front of Coal Mine Point, which rises to a height of 93 feet, the top being composed of hard boulder-clay capping the sandstone (see section attached to plan)	30	0
2. *Shale and sandstone*	5	0
3. *Sandstone*, gray	4	0
4. *Coal*, two thin layers and shaly parting	0	8
5. *Underclay and gray shale*	10	0
6. *Coal*	0	3
7. *Underclay* and gray shale	3	0
8. *Sandstone*, gray and irregularly laminated, with erect *Calamites* and *Stigmaria in situ*, also surfaces with vegetable débris. Seems to have been deposited by currents having the direction of E. and W., or nearly so	6	6
9. *Sandstone*, gray argillaceous, graduating into the preceding, with small concretions of ironstone. Erect *Calamites* and *Stigmaria in situ*, also fronds of *Alethopteris lonchitica*	1	6
10. *Shale*, gray, with a few small concretions of ironstone, the texture becoming finer downward (soft and crumbling when exposed to the weather). Many prostrate plants, including *Sigillaria*, *Stigmaria*, *Calamites Suckowii* and *C. Cistii*, *Lepidophloyos Acadianus*, *Corbaites borassifolia*, *Trigonocarpa*, *Sphenophyllum Schlotheimii*, *Pinnularia*, *Alethopteris lonchitica*, *Sphenopteris*, sp., *Lepidodendron Pictoense*. Also shells of *Naiadites carbonarius* and *N. elongatus*, scales and coprolites of fishes, and numerous valves of *Carbonia fabulina* and *C. bairdioides*	2	4
11. *Shale*, black and coaly. Fossils as in beds above, but more abundant and giving a carbonaceous character to the whole	1	1
[NOTE.—*Erect* Sigillariæ, *containing amphibian remains, stand on the next bed, and penetrate beds* 11, 10, *and* 9 *above, and some of them extend into bed* 8.]		
12. *Coal*, supporting erect *Sigillaria*. This coal is laminated, and shows numerous impressions of the bark of flattened *Sigillaria*	0	6
13. *Underclay*, gray, soft above, becoming harder below. Many *Stigmaria* roots with long rootlets	2	8
14. *Sandstone*, gray, with rootlets and some prostrate trunks of trees in the upper part	11	0
15. *Shale*, gray	0	7
16. Sandstone, gray	0	7
17. *Shale*, gray. Two erect trees, standing on bed below, penetrate this bed	3	6
18. *Coal*, and coaly shale, fern stipes, &c.	0	3
19. *Underclay*, with *Stigmaria* roots and rootlets	3	0
Total	86	5

Below this section is a thick series of sandstones and shales, intervening between the beds above and coal-group, No. XVI., of the general section. The sandstones contain numerous drift trunks of trees.

The great sandstone, No. 1, and the beds immediately below it appear in the face of Coal Mine Point, which has been produced by the resistance of the outcrop of this bed

to the encroachments of the sea. East of this the coast recedes, still presenting a high cliff in which the beds crop out one by one to the surface. In front of the point the great sandstone, No. 1, and the minor bed, No. 8, extend in reefs seaward, and owing to the great rise and fall of the tide in Cumberland Bay a length of about 330 yards of these reefs is exposed at low tide (see map, section, and view of the coast, Plates 46 and 47).

From information obtained by Henry Poole, Esq., it would appear that the cliff recedes at the rate of about 25 feet in 40 years, so that trees are rarely exposed in the bank, and those existing on the reef, and which are the most accessible, represent the effects of denudation extending over at least five centuries.

The relative positions of all the trees observed are seen in the plan and section, from which it would appear that they occur in groups. There is reason to believe, however, that these erect trees are only survivors of a much more dense forest, of which the weaker and more perishable trees had been overthrown. The positions of the trees extracted before 1878 could only be indicated approximately.

The manner of accumulation of the beds enclosing the erect trees is rendered evident by their character and contents, and has been noticed in my 'Acadian Geology,' p. 190, *et seq.* The details ascertained by the recent excavations may be stated as follows :—

The underclay, No. 13, represents a loamy soil on which *Sigillariæ* must have flourished for a long time, filling it with their roots and rootlets. The result was the accumulation of the coal, No. 12, which is filled with flattened and carbonised bark of these trees, as is the black shale constituting its roof Bark of *Lepidofloyos** is however largely associated with that of *Sigillaria* in these beds. Leaves of *Cordaites* also occur in this coal, and its mineral charcoal shows under the microscope bast fibres of the inner bark of *Sigillaria*, with scalariform, uniporous, and reticulated tissues, probably belonging to the wood of *Sigillaria*, *Lepidofloyos*, *Calamites*, and *Cordaites*.† Leaves of the latter genus, as I have shown (*op. cit.*), constitute a large part of some thin coals at the Joggins, and some portion of the ligneous matter, which in former papers I have referred to other genera, may, since the discoveries of Grand-'Eury, possibly be referred to *Cordaites*. The more compact portion of the coal when sliced shows shreds of epidermal tissue with a few rounded bodies, probably spores of ferns or lycopods.‡

* *Rhodendron* of some English palæobotanists.

† 'Acadian Geology,' p. 168; and paper on "Coal Accumulation," Jour. Geo. Soc.

‡ I cannot admit that the large trunks of silicified and calcified wood of the genus *Dadoxylon* (*Araucarioxylon*), so abundant in the coal-formation of Nova Scotia, belonged to *Cordaites*. Their foliage is more probably represented by the leafy twigs of *Walchia* or *Araucarites* found with them. It is also true that some ribbed trees with the markings of *Sigillaria* have wood of the structure attributed by Grand-'Eury and Renault to *Cordaites*. Where the dividing lines between *Sigillaria*, *Cordaites*, and *Dadoxylon* will finally be fixed remains somewhat uncertain. As I have elsewhere argued, however, it is evident that under the names *Sigillaria* and *Cordaites* are included cryptogamous and gymnospermous trees of very different grades.

After a quiet accumulation of vegetable matter, sufficient to give six inches of pure coal, the area must have subsided or been overflowed with water, probably brackish, in which *Naiadites* and Entomostracans established themselves, but in which for a time very little sediment was deposited, the dead plants remaining on the surface of the submerged swamp, and possibly others drifted to the locality, forming, with a little fine argillaceous matter, the material of carbonaceous shales. In the meantime the stronger and larger trunks of the *Sigillaria* forest remained erect, and around their bases there gradually accumulated layers of mud, constituting the shale, No. 10, including drifted plants, while it is not unlikely that the abundant remains of *Sphenophyllum* and *Pinnulariæ* represent aquatic vegetation growing on the surfaces of the accumulating mud. At this time the greater number of the trees had either not yet become hollow or were too tall to receive any sediment. A few, to be noticed in the sequel, were however either wholly or in part filled with clay.

By gradual silting up, possibly aided by a slight elevation, the area again became capable of supporting land plants, as evidenced by the erect *Calamites* and *Calamodendra* which rise from the surface of the shale, and by the *Stigmariæ* in the succeeding sandy deposit. The surface however now became subject to periodical or occasional inundations bearing sand, at first fine and argillaceous, but afterwards coarser. In the intervals of these inundations the thickets of *Calamites* and ferns which occupied the ground were tenanted by Batrachians, Millipedes, and Land Snails.

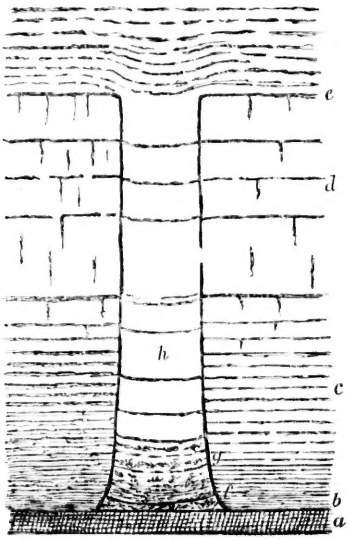
In the meantime the larger and stronger *Sigillaria*, which had remained erect, while sand was accumulating around their trunks, became hollow through decay, the strong outer rind alone remaining, while the inner bark and woody axis fell to pieces and dropped into the bases of the hollow cylinders. In this condition these hollow trees would constitute deep wells and pits in the soil, their openings more or less masked with herbage or with shreds of bark projecting above the surface. They no doubt served as places of retreat to Millipedes and Land-Snails; but to the small reptiles heedlessly passing over the surface they were pitfalls into which they fell, and being unable to escape, perished.

In connexion with this, it should be observed that the conditions of the case excluded all animals unable to creep or walk on land. Hence the assemblage of species in these trunks is of a special character, and includes none of those more aquatic forms of Batrachians which have been discovered in the aqueous deposits of the period. Further, only the smaller animals of the locality would be entrapped, larger species being little likely to fall into openings so narrow.

How long any of the hollow trees remained open it is impossible to say; but there is, as might be expected, evidence of successive stages and different modes in their filling. Some short bases of trees, resting on the coal and not extending into the shale, are mere disks of mineral charcoal, and may represent trees which had gone to decay even before the first submergence of the coal. Others seem to have been broken off before the close of the deposition of the shale, and are filled with that

material. Others remained open till the deposition of the overlying sandstone, and must have been still about 9 feet high, when finally filled. These are the most productive of animal remains. The normal character of the deposits in such taller trees is represented in fig. 1. At the base is a layer of mineral charcoal representing

Fig. 1.



Section of erect tree.

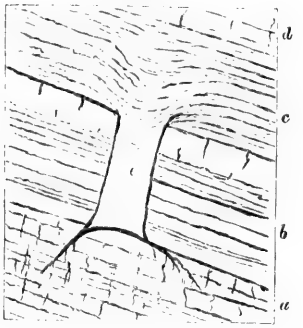
(*a*) Coal. (*b*) Coaly shale. (*c*) Gray shale. (*d*) Sandstone. (*e*) Land surface. (*d*) Argillaceous sandstone. (*f*) Mineral charcoal. (*g*) Carbonaceous deposit, with animal remains. (*h*) Sandstone, filling interior of trunk.

the débris of the trunk itself, and sometimes containing a sandstone cast of the pith. Above this is a variable quantity of more or less indurated sandy matter, in layers, which, owing to pressure, are often concave above. This is blackened with organic matter, and contains fragments of bark and comminuted plants, with occasional leaves of *Cordaites* or fragments of stems of *Calamites*. It contains the greater part of the animal remains, though a few of these occur in the sandstone above. This deposit, which is the productive layer of the several trees, evidently consists of matter which fell into the hollow trunks or was washed in by rains, while the trees were still open at the surface of the soil. Above this productive layer are layers or sometimes a continuous deposit of sand, by which the trees were finally filled, and which contains no organic remains except fragments of drifted plants. Thus the productive portion of each tree is found near its base. After the final filling and the deposition of additional sediment, the greater compressibility of the matter contained in the trees

caused this to settle somewhat, so that a funnel-shaped depression occurs over some of the taller trunks (figs. 1 and 2).

As opportunity occurred in the progress of the work, erect trees were extracted from other beds in the section, in the hope of discovering another fossiliferous forest; but with little positive result. In a trunk, about 15 inches in diameter, and standing in Section XXVI. of Division 4, Mr. A. T. Hill had found in 1876 several shells of *Pupa vetusta*. This tree, which was uniformly filled with compact argillo-arenaceous matter, was taken out, and a few additional *Pupæ* obtained, but no other remains; and no other trees could be seen in the bed (fig. 2). Another tree standing in Section XXIV., and 2 feet in diameter, was interesting in consequence of its well-marked Stigmarian roots, and of its standing on the sloping edge of a partially denuded shale (fig. 3). It contained no fossils.

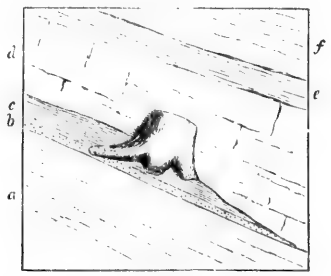
Fig. 2.



Erect tree in Section XXVI., containing shells of *Pupæ* and showing funnel-shaped depression.

(*a*) Underclay with roots and rootlets. (*b*) Sandstone and shale. (*c*) Shale. (*d*) Sandstone. (*e*) Shale filling tree and containing shells of *Pupa* in lower part.

Fig. 3.



Erect tree in Section XXIV.

(*a*) Sandstone and shale. (*b*) Sandstone. (*c*) Shale. (*d*) Sandstone. (*e*) Shale. (*f*) Sandstone. This tree had probably originally extended to the shale (*e*), or nearly so.

2. Characters and Contents of the Erect Trees.

It may be well in the first instance to present in a summary form the characteristics and contents of each tree extracted, taking them in order, from the shore cliff to the end of the reef, 1,063 feet in all, and including those extracted prior to 1878 with the others. The positions of the several trees may be seen on the plan and section.

No. 1. Lyell's tree of 1851, which comes first both in order of time and position. Diameter, about 17 inches; height, unknown; distance from crop of coal, No. 12, in bank, about 99 feet. Contained remains of *Dendrerpeton Acadianum*, *Hylonomus Wymani* or *Lyelli*, and *Pupa vetusta*.

No. 2. Extracted in 1860. Diameter, 1 foot 8 inches; height, 9 feet; distance from No. 1 about 73 feet; surface obscurely ribbed. Contained *Dendrerpeton Acadianum* and *Pupa vetusta*.

No. 3. Extracted in 1879. Diameter, 1 foot 8 inches; height, 2 feet 6 inches; distance about 20 feet from No. 2. Filled with argillaceous matter, and a little mineral charcoal at base. No animal remains observed.

No. 4. Extracted in 1879. A crushed coaly bark covering a mound of mineral charcoal. No animal remains observed. Distant about 20 feet from No. 3.

No. 5. Extracted in 1877. Diameter, 2 feet 6 inches; height remaining, about 4 feet. Surface with flat ribs. Distance from No. 4, 93 feet, and from the face of the cliff in 1879, 58 feet. This tree was extracted under unfavourable circumstances, owing to the interference of débris from the foot of the cliff, and high tides. It afforded portions of a skeleton of *Dendrerpeton Acadianum*, bones of *Hylonomus Lyelli*, *Pupæ*, and fragments of Millipedes. On one surface was a trail running round the circumference, indicating the efforts of an imprisoned Batrachian to escape. A few much decayed bones on this surface appeared to belong to *Dendrerpeton*.

No. 6. Extracted in 1879. Diameter, 2 feet; height remaining, less than a foot. This was probably the base of a tree, of which the upper part had been removed by the sea, leaving only the lowest layer. Afforded some much decayed bones, apparently of *Hylerpeton*. This tree was distant only a few feet from No. 5.

No. 7. Extracted in 1879. Distant from No. 5, 66 feet. Merely the base remaining. Consists of mineral charcoal without fossils.

No. 8. Extracted in 1879. Diameter, 1 foot 6 inches; remaining height, 1 foot. Consisted entirely of black carbonaceous matter with bones. It afforded several skeletons of *Hylonomus* and *Dendrerpeton*, the first observed remains of *Hylerpeton*, and many *Pupæ* and Millipedes. The skeletons in this tree were less disturbed than in any other I have examined; but owing to the long exposure of the base of the tree, after removal of the upper part, the material

was very soft and much mud-stained, and the bones in a crumbling condition. This tree and Nos. 7, 9, 10 and 11 constitute a group near to each other, and of which owing to recession of the cliff only the bases remained.

No. 9. Extracted in 1878. Short coaly base of a tree with a few bones of *Hylerpeton*, much decayed.

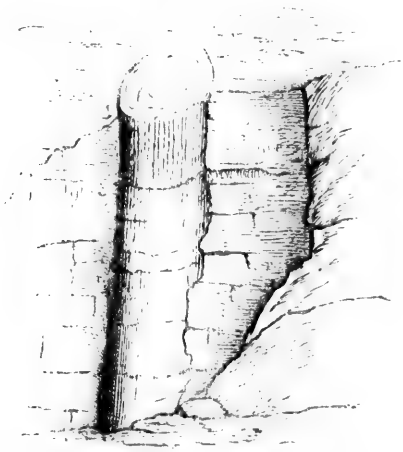
No. 10. Extracted in 1879. Diameter, 1 foot 6 inches. A short coaly base with much mineral charcoal. Detached bones of *Hylerpeton;* teeth and scales of *Spatrodus;* remains of larvæ of insects (?).

No. 11. Extracted in 1879. Diameter, 15 inches, much crushed; height, about 2 feet; filled with argillaceous matter; unproductive. Distant 8 feet from No. 7, and exactly opposite No. 10.

No. 12. Extracted in 1878. Diameter, 2 feet 4 inches; height remaining, 3 feet 6 inches; distant 20 feet from No. 11. Surface marked with broad ribs and rows of leaf-scars. In upper part gray sandstone, in bottom 4 inches of dark-coloured material which afforded bones of *Dendrerpeton* and *Hylonomus*, also Millipedes and *Pupæ*. Some of the cuticle of *Dendrerpeton* is preserved. This tree had been inclined to the south-west, and was consequently somewhat flattened, so that its diameter in one direction was double that in the other, and the lower side had been crushed or bent inwards. In the base there were two inches of mineral charcoal, and over this about 2 inches of hard and dark-coloured laminated matter, which afforded many *Trigonocarpa* and fragments of plants. It also contained the whole of the animal remains above referred to.

No. 13. Extracted in 1878 (fig. 4). Diameter, 1 foot 6 inches; height, 9 feet;

Fig. 4.



Tree No. 13, as it appeared when partially exposed in the reef.

distant 100 feet from No. 12; surface roughly ribbed. From the position and great height of this tree, we found it most convenient to undermine it and to extract its basal part, leaving the remainder intact in the reef (Plate 45, fig. 141). The base contained about a foot of dark-coloured matter, with remains of *Hylerpeton*, *Hylonomus*, *Smilerpeton*, *Pupæ*, and Millipedes. This tree must have been a pit at least 8 feet in depth when the reptiles fell into it.

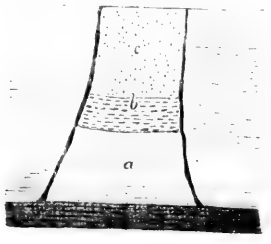
No. 14. Extracted in 1879. Diameter, 2 feet; height, 3 feet 6 inches; distant 13 feet from No. 13. Though there were in the base of this tree 3 inches of carbonaceous matter and mineral charcoal, no animal remains were found in it.

No. 15. Extracted in 1878. Diameter, 1 foot 6 inches; height remaining, 3 feet; distant 111 feet from No. 14. Consisted throughout of uniform gray sandstone without animal remains.

No. 16. Extracted in 1878. Diameter, 15 inches; height remaining, 4 feet 6 inches; distant 94 feet from No. 15. At the base had 6 inches of productive matter containing remains of seven individuals, of genera, *Smilerpeton*, *Dendrerpeton*, *Hylerpeton*, *Hylonomus*, and many *Pupæ* and Millipedes.

No. 17. Extracted in 1878. Diameter, 2 feet; height remaining, 2 feet. Close to No. 16. This tree had been filled in a somewhat peculiar manner (fig. 5). In

Fig. 5.



Tree No. 17, section showing material filling the interior.

(*a*) Gray shale filling lower part. (*b*) Carbonaceous matter containing animal remains. (*c*) Sandstone.

the bottom were 2 feet of gray shale without animal remains, as if at the time when shale was in process of deposition around the trunk some fissure or opening had admitted a quantity of this material. Subsequently, the usual thin deposit of productive carbonaceous matter occurred, and then the sandstone filling. This tree contained bones of *Hylerpeton* and *Hylonomus*, with remains of Millipedes.

No. 18. Extracted in 1878. Diameter, 2 feet 5 inches; height, 7 feet; distant 44 feet from No. 17. Obscure ribs and leaf-scars. Filled with argillaceous matter, and destitute of animal remains. In the base was a layer of mineral charcoal,

holding a sandstone cast of the medullary cylinder, 2 inches in diameter. The trunk spreads at base to 3 feet, and extends its *Stigmaria* roots on the roof of the coal. A prostrate and flattened trunk of *Lepidofloyos* was found immediately below it.

No. 19. Extracted in 1876. Diameter, 1 foot 6 inches; basal part, about a foot thick and partially compressed, alone seen; the upper part having been removed by the sea. The productive matter in its base afforded 13 skeletons of *Dendrerpeton*, *Hylonomus*, *Hylerpeton*, and *Fritschia*, besides Millipedes and *Pupæ*.

No. 20. Extracted in 1878. Diameter, 1 foot; distance from No. 18, 126 feet; Filled with shaly matter not productive.

No. 21. Extracted in 1878. Diameter, 1 foot 8 inches; height remaining, 4 feet; distant from No. 20 26 feet. About 5 inches of carbonaceous matter in the base, containing remains of *Hylonomus*, *Hylerpeton* and *Smilerpeton*. This tree is much crushed by lateral pressure at the base, and the bones obtained from it were in a fragmentary condition.

No. 22. Extracted in 1878. Diameter, 2 feet 3 inches; height remaining, 3 feet. Filled with sandstone to base, without fossils.

No. 23. Extracted in 1878. Diameter, 1 foot 6 inches; base only preserved. Close to No. 22. Some carbonaceous matter in the base believed to be productive, but accidentally mixed with the contents of No. 16.

No. 24. Extracted in 1878. Diameter, 15 inches; height remaining, 3 feet; distant 8 feet from No. 23. A little carbonaceous matter in hard laminæ of sandstone in base. Contained a few scattered scales and bones of *Dendrerpeton*, and some jointed objects supposed to be insect larvæ.

No. 25. Not extracted. About 18 inches in diameter, and several feet in length. Distant 136 feet from No. 24. This trunk is prostrate and partially flattened. It is visible only at very low tides, and I had no opportunity to extract it. Being prostrate, and so far distant from No. 24, it may possibly mark the limit of the erect trees in this direction.

It will be observed that of the erect trees catalogued above, ten were altogether unproductive. Of these, some had evidently been broken down and filled while the area was still submerged. Others, on the contrary, had remained inaccessible to animals till suddenly filled by the final irruption of sand. The intermediate conditions were those favourable to the entombment of land animals. Fifteen trees were more or less productive: a remarkable proportion when the combination of circumstances necessary to this result is considered. The greater part of the remains have however been obtained from nine or ten of the trees catalogued; but some of the others were only bases of trunks from which more productive portions may have been removed by the sea. The more productive trees are intermixed with the others, and there seems

no local restriction in this matter, unless the scarcity of the erect trees toward the end of the reef may indicate a margin of the forest in that direction.

The trees range in diameter from a foot to nearly 3 feet, the ordinary diameter being about 18 inches. The measurements of diameter were made at a short distance above the base, where the trunks became approximately cylindrical. The extreme diameter of the largest tree at the base was 3 feet. The measurements of height refer to the actual condition of the trees. The maximum height of trees which had lost nothing by denudation is 9 feet; but several of those now of less height may, previously to the modern denudation of the beds, have been as tall as any of the others.

So far as can be ascertained, all the trees affording amphibian remains as well as the others standing erect with them, belong to the genus *Sigillaria* in its wider sense, or to the family *Sigillariæ*. Those retaining markings have the characters of the broad-ribbed species of *Sigillaria* proper, like *S. reniformis* and *S. Brownii*, which seem to have been among the largest trees of the coal-period, and those best fitted, by the density and indestructibility of their outer bark, for retaining an erect position. Trunks and branches referrible to the subdivisions *Rhytidolepis* and *Favularia*,* and also trunks of *Lepidophloyos*, occur in a flattened condition in the black shale; and these as well as *Cordaites* must have constituted portions of the same forest, though none of them endured long enough to become repositories of amphibian remains. All the erect trees, so far as observed, had roots of the Stigmaria type.

It is deserving of remark in this connexion, that the circumstances of the growth and entombment of this forest entirely contradict those theories as to *Sigillaria* and *Stigmaria* which suppose that these plants grew in water or on submerged areas. In the present instance the surface on which the trees grew, now represented by the 6-inch coal, must have been underlain by several feet of peaty matter with prostrate trunks of trees, and no remains of aquatic animals. The forest contained not only *Sigillariæ* of different species but *Lepidophloyos*, *Cordaites*, and *Ferns*. When the area was submerged this vegetation was killed, while plants like *Sphenophyllum*, which could grow in water, apparently took its place, and were in turn replaced by *Sigillariæ* and *Calamites* when the area again became land. Further, when the reptiles fell into the erect trees the surface on which they walked, though subject to inundations, must ordinarily have been several feet above the drainage level, otherwise the hollow trees would have remained full of water.

No remains of any aquatic animals were found in the trees holding amphibian remains, unless certain minute annulated bodies, doubtfully compared by Dr. Scudder to leeches, can be regarded as of this character. The vegetable matters present consisted, first of the decayed material of the interior of the trunk itself, and, secondly, of fragments which had fallen into or been drifted into the trees after they became hollow. Most of these were pieces of bark and wood, but leaves of *Cordaites* were not un-

* See 'Acadian Geology,' p. 432-3.

common, and there were numerous specimens of the little nutlets which I have elsewhere named *Trigonocarpum sigillariæ*,* and which must be fruits either of *Sigillaria* or of *Cordaites*. Pinnules of *Alethopteris lonchitica* were also occasionally met with, and fragments of *Calamites*. In one tree there occurred so large a mass of aerial roots of the type of *Psaronius*, as to render it probable that these roots may have grown in the interior of the decaying tree.

With reference to the mode of occurrence of the animal remains, it is to be observed that from the manner of their entombment all the bones of each specimen must be present in the matrix. On the other hand, having dropped asunder on decay of the soft parts, and having been liable to disturbance by water dripping into the trunks, they are often much displaced. In some instances, also, they have evidently fallen into the crevices of loose vegetable matter, afterwards consolidated. Besides this, the original inequality of the surfaces of deposit has been increased by the effect of pressure in depressing the centre, so as to give a basin-form to the layers and to produce a certain amount of displacement at the sides. The effect of this is increased by the circumstance that some of the amphibia seem to have crept close to the sides of the cavity in which they were imprisoned, and to have died in that position, so that their bones lie close to the bark, and in the portion of the deposit most bent by pressure. It is thus difficult to collect the whole of the bones belonging to a skeleton, and impossible to expose some of them without destroying others. I have been obliged, in consequence, to endeavour to secure and expose the more important portions of the skeleton in as perfect condition as possible, and in many instances it has proved possible to recover only a portion of the bones. The state of preservation of the remains is very different in different layers. In some cases considerable portions of the cuticle remain in a carbonised state; this has occurred when carcases have been quickly covered with moist débris, or permanently water-soaked, so that the soft parts could become carbonised instead of decaying away. These portions of cuticle are unfortunately not laid out flat, so as to show the form of the animal, but much folded and crumpled; and it would seem that where the cuticle has been thus preserved the bones have been specially liable to decay. The bones are often much softer than the matrix and of a brownish colour, but in some instances they are quite white and in excellent preservation. On a few of the surfaces they have been partially removed by the percolation of water. Their cavities are usually occupied with calcite, but sometimes with pyrite. When sliced they generally show their microscopic structure in a good state of preservation, though the presence of hard grains of pyrite in the softer bone often makes it difficult to prepare satisfactory slices. In a few cases bones of small amphibia and shells of *Pupa vetusta* have been found included in the mineral charcoal which forms the lowest layers in the trees, as if these animals had crept into the interstices of the fragments of decaying wood and bark.

* 'Acadian Geology,' p. 477.

3. Description of the Animal Remains.

Batrachians.

As already stated, the circumstances attending the entombment of vertebrate animals in erect trees were of such a nature as to exclude the more aquatic forms. The species found in these repositories, therefore, constitute a special and peculiar assemblage, representing the more terrestrial types of the batrachian or amphibian life of the period.

The whole of the amphibian animals found in the twenty-four trees extracted may be included in twelve species, of which two are of doubtful character, owing to the imperfection of their remains. Of the remaining ten, eight belong to the family which I have separated* under the name *Microsauria*, and two are referable to the *Labyrinthodontia*, though perhaps to a special subdivision of that group. The whole may be included in the order *Stegocephala* of Cope.

The *Microsauria* are characterised by somewhat narrow crania, smooth cranial bones, simple or non-plicated teeth, well-developed limb bones and ribs, elongated biconcave vertebræ, bony plates and scales on the thorax and abdomen, and horny scales on the back and sides.

Though probably to be included in the group *Stegocephala*, as defined, and predominantly Batrachian in their affinities, they presented in form, clothing, and probably in habits of life, a close approximation to the lacertians. Their predominating terrestrial habits are evidenced by the circumstance that in nearly all the species the length of the femur coincides very nearly with that of the mandible, while their lacertian form is indicated by the fact that in death their crania and skeletons lie on one side and not on the back or front.

The following genera of this group are represented in the erect trees of the South Joggins :—

1. *Hylonomus.*—Form lizard-like, with the posterior limbs somewhat large in proportion to the anterior. Size, small. Mandibular and maxillary teeth numerous, small, conical, pointed. Palatal teeth minute. Abdominal scales oval. Four species, namely, *H. Lyelli*, *H. Wymani*, *H. multidens*, *H. latidens*.

2. *Smilerpeton.*—Form somewhat elongated and limbs short. Mandibular and maxillary teeth wedge-shaped, with cutting edges. Palatal teeth numerous, some of them large. Abdominal scales oval. One species, *S. aciedentatum*.

3. *Hylerpeton.*—Body stout with strong limbs. Mandibular and maxillary teeth strong, not numerous, grooved at apex. Palatal teeth numerous and some of them large. Thoracic plate broad. Abdominal scales pointed or oat-shaped. Two species, *H. Dawsoni* and *H. longidentatus*.

4. *Fritschia.*—Body lizard-like. Limbs large and well ossified. Mandibular

* 'Air-breathers of the Coal Period.'

and maxillary teeth conical, grooved at apex. Abdominal scales slender and rod-like. One species, *Fritschia curtidentata*.

5. *Amblyodon*.—A genus characterised by stout cylindrical teeth, blunt at the apices; but otherwise imperfectly known.

The *Labyrinthodontia* are represented in these trees by the genus *Dendrerpeton* alone.

Dendrerpeton may be characterised as having a lizard-like form of body, with the anterior and posterior extremities nearly equal; the skull somewhat elongate with small orbits, and the nostrils placed at the front. The cranial bones sculptured. The teeth plicated at the base, more especially on their inner sides. A series of large teeth on the palate. The body was covered above with imbricated horny scales and had lappets or pendants at the sides. The abdomen was protected by thin bony scales semi-elliptical or oat-shaped in form, and arranged in a chevron pattern. There was probably also a thoracic plate. Two species, *D. Acadianum* and *D. Oweni*.

Of the above species six were more or less perfectly known previous to the recent explorations, but additional material has been obtained illustrating some of their characters. In the following notes these new facts will be stated, with more full descriptions of the new species.

1. *Hylonomus Lyelli*, Dawson (Plate 39, figs. 1 to 14, and fig. 27; also Plate 45, fig. 140).

[Journal of Geological Society of London, vol. xvi., 1859, p. 268. 'Air-breathers of the Coal Period,' 1868, p. 40. 'Acadian Geology,' 3rd edition, 1880, p. 370.]

This species is by much the most abundant in the erect trees examined. It is the type of the genus *Hylonomus* and of the family *Microsauria*. Its characters may now be given somewhat completely, as follows:—

General form lizard-like, with the hind limbs rather larger than the fore-limbs. Length when mature, 5 to 6 inches.

Head somewhat elongate; bones of skull smooth or with microscopic striæ, perfectly united, except at parietal foramen. Occipital condyle double, and apparently bony. Teeth simple, conical, numerous, about forty in each mandible, and nearly equal, except that a few of the anterior ones are rather larger than the others. The teeth are anchylosed to the jaw in a furrow protected by an external bony plate.

Vertebræ with cylindrical bodies, slightly concave at the ends. When partly exfoliated they appear hourglass-shaped, in consequence of the internal cartilage having the form of two cones attached by their apices. Zygapophyses conspicuous above; neural arches united to the bodies of the vertebræ, and with broad neural spines. Dorsal vertebræ with strong lateral processes. Caudal vertebræ apparently simple and cylindrical. Number of vertebræ in neck and trunk about thirty.

Ribs long and curved, with capitulum and tubercle, cartilaginous within.

Anterior limb slender, humerus with distinct keel; radius and ulna separate; toes, four or five.

Posterior limb with well-developed femur, with a trochanter and bifid articulatory surface at distal end; tibia and fibula shorter, separate; toes five, somewhat long and slender.

Pelvis large, principally composed of two large broad triangular ilio-ischiac bones.

Tail probably shorter than the body; thirteen vertebræ seen in one specimen.

Lower surface protected with a thoracic plate and numerous oval bony scales, with delicate lines of growth externally, and concave internally with thickened edges. Upper surface protected with imbricated horny scales. In front two rows of horny tubercles and plates, with epaulettes composed of bristle-like fibres projecting from the skin (Plate 39, fig. 27; Plate 45, fig. 140).

The dimensions of the largest individual found are as follows:—

Length of head	about	2	centimetres.
,, neck	,,	1·3	,,
,, trunk	,,	7	,,
,, posterior limb to heel		3	,,
,, mandible		1·8	,,
,, rib		1·3	,,
,, humerus		1·4	,,
,, femur		1·8	,,
,, tibia		1·2	,,
,, body of vertebra		2·5	millimetres.

Teeth, five in 1 millimetre.

A smaller individual gave the following measurements:—

Length of mandible	7	millimetres.
,, rib	6	,,
,, humerus	5	,,
,, femur	7	,,

Under the microscope the bone of *Hylonomus Lyelli* shows well-marked cells and canaliculi, the cells being oval in the cranial bones and more elongated in the limb bones. The dentine of the teeth presents very fine tubes radiating from the pulp cavity, and covered with a thin plate of structureless enamel at the outer surface.

In such specimens of this animal as are preserved in sufficient perfection to show its attitude, the head and trunk lie on one side, showing that the body was compressed laterally; a form fitting it to pass among dense vegetation. Coprolitic matter associated with its remains contains fragments of insects.

2. *Hylonomus Wymani*, Dawson (Plate 39, figs. 15 to 17).

[Journal of Geological Society, *l.c.* 'Air-breathers of the Coal Period,' p. 52. 'Acadian Geology,' p. 378.]

As compared with the last species this was smaller in size, more elongated in form, had the teeth less numerous (about twenty-two in the mandible), and shorter and more obtuse in form. There are six to seven in 1 millimetre.

Length of skull	8	millimetres.
„ mandible	5	„
„ rib	5·5	„
„ femur	6	„
„ humerus	5	„

This species is much more rare than the former; but quantities of minute bones, probably belonging to it, occur in the coprolitic matter.

Other characters of this species will be found in the memoir and work above cited.

3. *Hylonomus multidens*, s.n. (Plate 39, figs. 23 to 26).

This animal is known only by portions of bones of the head and a few other fragments. The scattered bones of the extremities are inseparable from those of *H. Lyelli* occurring with it. As compared with that species, the bones of this are smoother and more delicate. The teeth are more numerous and slender. The crushed distal end of a femur or humerus found near the skull indicates that the limbs were well developed.

Length of mandible	11	millimetres.
„ skull	about 15	„
„ femur	„ 9	„

Teeth, five to six in 1 millimetre.

4. *Hylonomus latidens*, s.n. (Plate 39, figs. 18 to 22).

Of this species fragments of three specimens were found in three distinct trees. It seems to have been somewhat stouter built than *H. Lyelli*, but with the limbs shorter in proportion. Its generic affinities are perhaps somewhat doubtful, as it presents in some respects characters intermediate between *Hylonomus* and *Hylerpeton*.

Mandibular and maxillary teeth broadly conical, about twenty in each mandible—three

in 1 millimetre; anterior mandibular teeth somewhat larger than the others, and bent or hooked. Vomer or palate with minute teeth. Thoracic plate large. Scales of abdomen oval, but somewhat narrow, and tending to be oat-shaped.

Length of mandible (imperfect)	. . . .	9	millimetres.
,, humerus	. . . . .	7	,,
,, vertebra	. . . . .	2	,,
,, tibia (?)	. . . . .	5	,,
,, thoracic plate	. . . . .	1·5	centimetre.
,, six caudal vertebræ	. . . . .	8	millimetres.

5. *Smilerpeton aciedentatum*, Dawson (Plate 40, figs. 28 to 45).

[*Hylonomus aciedentatus*, Dn., Journal of Geological Society, *l.c.* 'Air-breathers of the Coal Period,' p. 49. 'Acadian Geology,' p. 376.]

This animal was originally referred by me to the genus *Hylonomus;* but additional specimens and more careful comparison oblige me to place it in a new genus.

Its most remarkable distinction is the form of the mandibular and maxillary teeth, which are of a peculiar wedge-shape, being broad and oval at base and narrowed to a longitudinal edge at top. Thus, when viewed from the side they appear narrow and blunt, but when the jaw is broken across, and they are viewed from the rear or front, they appear broad and sharp-edged. The effect of this arrangement is that the jaw is armed with a closely-placed series of chisels or wedges, giving an almost continuous edge. At the end of the mandible some of the teeth are longer and more conical.

Another important character is that the palatal and vomerine bones seem to have bristled with teeth, mostly of very small size; but there are also some larger palatal teeth, of which some are sharply pointed and others blunt with furrowed points.

The vertebræ are of the same type with those of *Hylonomus;* but some which appear to be caudal have a pointed spine above, indicating perhaps a flattened tail. The ribs are short and stout.

Only a few fragments of the limbs have been found; they would seem to have been less developed than in *Hylonomus*, and perhaps this animal was less gifted with powers of walking on land than any of the other *Microsauria*. This would accord with the fact that its bones are much scattered, and occur chiefly in sandy layers, as if introduced in times of rain or of partial inundation.

Some fragments indicate thoracic plates, and there are numerous abdominal scales of oval form. Above, the body appears to have been clothed with small tubercles and horny scales, and to have had cuticular pendants like those of *Dendrerpeton*.

In a large specimen the mandible measures 2·2 centimetres, the femur 2 centimetres, and a rib the same. The following are measurements from a smaller specimen:—

Length of mandible	. . . . .	1·5 centimetre.
„ femur	. . . . .	1·5 „
„ humerus (?)	. . . . .	1·3 „
„ vertebra	. . . . .	3·5 millimetres.
„ rib	. . . . .	1 centimetre.

There are five teeth in 2 millimetres.

Under the microscope the bone shows elongated cells and a somewhat fibrous structure, and there is much cartilage associated with it. The teeth are composed of radiating tubes of ivory of remarkable coarseness, and with distinct lateral canaliculi; but the coarse tubes do not reach the surface to which only their terminal canaliculi extend, and there appears to be a thin superficial layer of dense and brilliant enamel having externally a microscopic vertical striation.

The above characters are taken from two specimens approaching each other in dimensions. A third specimen was of much smaller size, and had longer and more slender palatal teeth. It was originally set apart as a second species, under the name *S. acutidentatum*; but as the bones secured are few, and it may possibly be a young individual of the present species, I have thought it best to leave it undescribed in the meantime.

6. *Hylerpeton Dawsoni*, Owen (Plate 41, figs. 62 to 85).

[Owen, Journal of Geological Society, vol. xviii., p. 241. Dawson, 'Air-breathers of the Coal Period,' p. 55. 'Acadian Geology,' p. 380.]

The specimen on which Owen founded this genus and species was obtained by me in 1861. Unfortunately it consisted of only a few fragments of bone, the principal of which was a mandible, with some of the teeth remaining, and a fragment of a maxilla. The trees subsequently examined have afforded bones belonging to four additional individuals, and enable the following description to be given.

Bones of skull slightly striated, but not sculptured as in *Dendrerpeton*. Lower jaw with distinct ascending ramus or coronoid process, a feature not known in any other of these amphibia, but observed by Cope in his genus *Brachydectes*, which may be allied to *Hylerpeton*, but is known only by the jaws and teeth. Teeth, twelve in each ramus of the mandible, bluntly conical, slightly striated at the apex. Pulp-cavities large and longitudinally striated at the sides, though the teeth are not folded. Maxilla furnished with similar teeth, one of which near the front is larger than the others. Palatal teeth numerous, small and conical, with a few large teeth at the sides.

Vertebræ short, cylindrical, well ossified, with well developed zygapophyses and neural spines; ribs strong and much curved, with well developed division of the proximal ends; pelvis imperfect, but apparently large, with broad ilium.

Humerus half the length of the mandible; radius half as long as humerus; femur

very large and stout, nearly as long as the mandible; leg bones and phalanges correspondingly stout.

The thoracic plate is indicated only by some fragments. The abdominal scales are narrow and pointed (oat-shaped), smooth externally and with a ridge at one side within.

The following are dimensions of the largest specimen:—

Length of	mandible	4·4 centimetres.
,,	largest tooth	5 millimetres.
,,	femur	3·5 centimetres.
,,	tibia	2 ,,
,,	humerus	2 ,,
,,	radius	1·5 ,,
,,	vertebra	6 millimetres.
,,	rib	3 centimetres or more.
,,	scales	5 to 7 millimetres.

Under the microscope the bone presents a coarser structure than that of *Hylonomus*, the bone-cells being large and of elongated form. The dentine of the teeth has coarse tubes with canaliculi, the appearance being very similar to that in *Smilerpeton*, though the tubes are scarcely so large.

It seems evident that *Hylerpeton Dawsoni* was an animal somewhat stout and broad in form, with a large and pointed head and massive limbs. It seems to have fed in part at least on Millipedes, as remains of these are found in coprolite associated with its bones. For some reason also, the specimens of this species seem to have been among the earliest introduced into the erect trees. Perhaps they sought their myriapodous food near these hollow trunks, or were in the habit of breaking up decayed wood in search of Myriapods.

7. *Hylerpeton longidentatum*, s.n. (Plate 42, figs. 86 to 109).

[Preliminary Notice, American Journal of Science, December, 1876.]

Two specimens of the species occur in the collections, neither of them perfect. Their characters warrant us in placing the animal in the genus *Hylerpeton*, but it is very distinct from the previous species, more especially in the length and slenderness of its teeth, and in the breadth of its thoracic plate.

Head much elongated, with the bones minutely pitted, and with delicate microscopic striæ, but not sculptured. Mandibular and maxillary teeth long and acute, pointing backwards, with the apex of their inner sides finely striated; twenty or more in each ramus of the lower jaw; palatal bones with several long slender teeth and many

minute teeth. The mandibles found are not complete, but there are indications that there was an ascending process as in *H. Dawsoni*, but less developed. The narrowness of the dentary bone in Plate 42, fig. 86, is caused in part by the lower posterior edge being bent inward at (*a*), and by the posterior end being broken off above.

Vertebræ short and stout, and apparently well ossified. Ribs long, with double head and much curved.

Humerus longer than the femur, which is short and stout, if the bone taken for it is rightly determined.

Abdominal scales narrow, oat-shaped; thoracic plate large, broadly oval.

Length of mandible	4	centimetres.
,, vertebra	5	millimetres.
,, rib	2·5	centimetres.
,, humerus	1·5	,,
,, femur (?)	1·2	,,
,, tibia	8	millimetres.
,, mandibular teeth	3	,,

Six to seven teeth in 1 centimetre.

Under the microscope, the bone shows somewhat elongated cells similar to those of *H. Dawsoni*, but smaller. The teeth in cross-section near the base, present a somewhat complex structure, though the dentine is not folded. Next the pulp cavity there are straight radiating cells or tubes, coarse and with lateral canaliculi. This structure, which resembles that of *H. Dawsoni*, extends about half way to the surface, when the large tubes cease and the canaliculi form a dense network. On the outside of this is a thick layer of enamel with fine straight canaliculi. A section nearer the apex of the tooth would probably show a less thickness of the second or intermediate layer.

8. *Fritschia curtidentata*, s.n. (Plate 43, figs. 110 to 128).

[*Hylerpeton curtidentatum*, Preliminary Notice, American Journal of Science, *l.c.*]

This species is represented in the collections by two specimens—one well preserved and probably adult, the other smaller and less perfect. In 1876, when I possessed but one specimen, I referred it to *Hylerpeton;* but it differs from that genus in the absence of palatal teeth and in the abdominal armour, which consists of long slender rods instead of scales. This kind of protective structure, as is well known, occurs in Huxley's genus *Ophiderpeton*—a creature otherwise very different—and in Cope's *Sauropleura*, which in the parts known has much resemblance to the present genus.*

* Certain species of *Urocordylus* described by Huxley and Fritsch would seem to present forms of scales intermediate between the oat-shaped and rod-like types.

I have dedicated the genus to Professor ANTON FRITSCH, who has so ably illustrated the carboniferous and permian Batrachians of Bohemia.

Bones of the head very smooth, having only a few microscopic punctures. Teeth conical, somewhat obtuse, striated at the inner side of the apices; there are about thirty in each ramus of the mandible, and about twenty-seven in the maxillary bone. As in the other *Microsauria*, they are implanted in a furrow.

Vertebræ short and well ossified, three in a centimetre. Ribs strong, curved, about 1 centimetre in length.

Limbs robust, the bones better ossified than in any of the other species of *Microsauria*. Humerus round, and with a distinct keel on the shaft. Femur with well-formed articulating surfaces. Toes of hind foot probably five, central ones long and slender.

Thoracic plate of moderate size and somewhat rounded. Abdomen protected by needle-like rods, which are very numerous, and were probably arranged *en chevron*.

Length of mandible (not quite perfect) . .	2·1	centimetres.
„ maxilla	2	„
„ rib.	1	„
„ humerus	2	„
„ femur.	2·4	„
„ radius and tibia . . . . about	1	„
„ toe of hind foot	7	millimetres.

Eight teeth in 5 millimetres.

Under the microscope the bone shows small rounded cells with numerous canaliculi. The cells in the limb bones are a little longer than the others. The teeth are simple, and consist of dentine traversed by moderately fine and somewhat tortuous tubes; these are much coarser than in *Hylonomus*, but finer than in *Hylerpeton*.

9. *Dendrerpeton Acadianum*, OWEN (Plate 40, figs. 46 to 51; and Plate 44, figs. 129 to 137, except fig. 131).

[OWEN, Journal of Geological Society, vol. ix. DAWSON, 'Air-breathers of the Coal Period,' p. 17; 'Acadian Geology,' p. 362.]

Portions of several specimens of this species are in the new material, but do not add much to the knowledge of its characters, which have been fully given by OWEN from the somewhat complete specimens obtained by me in 1859.

Some interesting fragments of cuticle were found in association with one of the skeletons, which show very well the scaly covering of the back and the lappets and edge-scales of the sides. These last probably formed a border or margin to the bony scales covering the abdomen (Plate 40, figs. 46 to 51).

A specimen of the skull was also obtained showing its internal surface, and exhibiting clearly the sutures of the several bones. This I have submitted to Professor Cope, and give a diagrammatic representation of it (Plate 44, fig. 132), showing his interpretation of the several bones, which apparently accord in number and arrangement with those of *Labyrinthodontia*, but differ from those of the *Microsauria*, in so far as the crushed condition of these latter enable an opinion to be formed.

Under the microscope, the bone of *Dendrerpeton* presents large and somewhat rounded or oval cells with numerous canaliculi filling the intermediate spaces. The teeth have the dentine folded at the base, but sometimes only on the inner side. The tubes of the dentine are simple and fine, in this resembling those of *Baphetes* and other Labyrinthodonts.

The abdomen of *Dendrerpeton* was protected by numerous broadly sub-oval scales, arranged *en chevron*, but I have not been able to detect with certainty any thoracic plate, though I have one specimen which I think may be a part of such a plate.

Other characters of this species will be found in the memoir and works above cited.

10. *Dendrerpeton Oweni*, Dawson (Plate 44, figs. 131, 138, 139).

[Journal of Geological Society, vol. xviii., p. 469. 'Air-breathers of Coal Period,' p. 32. 'Acadian Geology,' p. 368.]

This species is represented by four specimens in the new material, and these serve to establish its distinctness from the last mentioned, in its smaller size, its more delicate cranial sculpture, and its longer and more curved teeth. Its abdominal scales are also narrower and more pointed, approaching in this to the oat-like form of those of *Hylerpeton*. So far as known, the scaly covering of the back of this species was similar to that of *D. Acadianum*.

Other characters of the species will be found in the memoir and works above cited.

11. *Sparodus*, sp. (?) (Plate 40, figs. 52 to 56).

In the coaly matter or mineral charcoal at the base of tree No. 10, appeared a few fragments of an animal which may possibly belong to the above-named genus of Fritsch, though I am by no means certain of this identification or of the real nature of the animal.

The skull is represented by a fragment of a maxillary or intermaxillary bone, with blunt conical teeth. It is smooth or marked merely with microscopic dots. There is also a fragment which may be a palatal bone studded with minute teeth.

A few vertebræ associated with the above bones are long and narrow, with large zygapophyses and long neural spines. Length of body about 3 millimetres.

With these remains are a few bony scales different from those of any other species found in these trees, and more resembling scales of Ganoid Fishes. They are somewhat rectangular in form, enamelled on the surface and beautifully sculptured with waving lines.

In the same trunk were found some teeth and bones referable to *Hylonomus Dawsoni*, and it is not impossible that the remains above referred to may have belonged to some creature devoured by that animal, and which would not otherwise have obtained admission to the interior of an erect tree. The tree itself had been removed by the sea, all but a little of the base, and this was in a very unsatisfactory state, so that doubt might even exist as to the limit between the deposit in the interior of the tree and that under its base.

12. *Amblyodon*, gen. nov. (Plate 40, figs. 57 to 61).

In tree No. 16 were found a few teeth and bones which do not seem referable to any of the genera above named, though pretty certainly belonging to a member of the group of *Microsauria*.

A fragment of a jaw 1 centimetre in length has ten cylindrical teeth, simple and smooth, with large pulp cavities and rounded regularly at the apices. With these are four vertebræ of the usual type, measuring together 1 centimetre. Fragments of cranial bones also occur and are obscurely pitted. There is also what seems to be the shaft of a limb bone and a few oval scales. A flat, somewhat rhombic bone with a style at one side may possibly be a thoracic plate or possibly a parasphenoid.

The material is too scanty for any satisfactory description of this animal, but I have named it provisionally *Amblyodon problematicum*.

13. *Coprolitic Matter*.

This occurs in several of the trees, not in masses of regular form but in indefinite patches. It is of a gray or buff colour, and usually highly calcareous. It is often filled with comminuted bones not determinable; but evidently of small Batrachians and probably of *Hylonomus*. Fragments of chitinous matter also abound in some of the coprolitic masses. In most cases they seem to belong to Millipedes, but in a few examples insect remains occur. They are not determinable; but in one specimen was a well-preserved fragment of a head apparently of a small neuropterous insect showing one of the compound eyes. Fragments of shells of *Pupa* are found in and near some of the coprolitic masses, and I think it probable that these pulmonates formed a part of the food of some of the Batrachian species.

Some doubt must of course exist as to whether the substances contained in the coprolite represent the ordinary food of the amphibia or only that to which they had access while imprisoned in the erect trees. The facts so far as they go would indicate

that the larger amphibian species preyed upon the smaller, and the latter on Insects, Millipedes and *Pupæ*.

14. *Land Snails.*

The additional facts obtained in relation to these I have detailed in a paper communicated to the American Journal of Science.* *Pupa vetusta* proves to be by far the most abundant species. A very few crushed specimens of *Zonites priscus* were detected. The only new species found is a minute *Pupa* of different type from *P. vetusta*, and which I have named *P. Bigsbii*. These three species, with two described by BRADLEY from the coal formation of Illinois (*Pupa Vermilionensis* and *Dawsonella Meeki*) and a third from Ohio, recently described by Professor WHITFIELD (*Anthracopupa Ohioensis*) are so far the only known carboniferous pulmonates. The shell which I have named *Strophites grandæva*,† from the Devonian of New Brunswick, is probably a still older representative of this group. Details with respect to them will be found in the paper in the American Journal of Science above referred to, and in that of Professor WHITFIELD in the same Journal for February, 1881.

15. *Millipedes, &c.*

Much additional material of this nature was obtained, but mostly in a very fragmental condition. On careful examination, I was able to refer nearly all the specimens to the species of *Xylobius* and *Archiulus*, already distinguished by Dr. SCUDDER in the material from the trees previously excavated. A number of other fragments, which seemed to indicate additional forms and species of arachnids, have been placed in Dr. SCUDDER's hands, and also some jointed objects which may be remains of larvæ of insects.

CONCLUSION.

It may be interesting to note the whole number of individual animals represented by the amphibian remains found, and the trees in which they were contained, as an indication of their distribution and relative abundance.

Microsauria.

1. *Hylonomus Lyelli*	12 specimens.	Trees No.	5, 8, 12, 13, 16, 19.
2. *H. Wymani*	7 ,,	,,	1, 8, 17, 19, 21.
3. *H. multidens*	1 ,,	,,	17.
4. *H. latidens*	3 ,,	,,	12, 13, 21.
5. *Smilerpeton aciedentatum* .	3 ,,	,,	8, 13, 21.
6. *Hylerpeton Dawsoni* . . .	6 ,,	,,	6, 8, 9, 10, 16, 19, 21.
7. *H. longidentatum*	3 ,,	,,	16, 17, 19.
8. *Fritschia curtidentata* . .	3 ,,	,,	19, 21.
9. *Amblygodon problematicum* .	1 ,,	,,	16.

* November, 1880. † Ibid.

Labyrinthodontia.

10. *Dendrerpeton Acadianum* .	9 specimens.	Trees No. 1, 2, 5, 8, 12, 13, 19, 24.
11. *D. Oweni*	4 „	„ 8, 16, 19.

Incertæ Sedis.

12. *Sparodus*, sp. (?)	1 specimen.	Tree No. 10.

Total individuals, 53.

The negative result that, under the exceptionally favourable conditions presented by these erect trees, no remains of any animals of higher rank than the *Microsauria* and *Labyrinthodontia* have been found deserves notice here. It seems to show that no small quadrupeds of higher grade inhabited the forests of Nova Scotia at the period in question. This is perhaps confirmed by the remarkably Lacertilian characters assumed by the *Microsauria* of the period, which seem to have occupied the place now taken by the smaller true reptiles. That there were larger Labyrinthodonts than those found in the erect trees we know from the *Baphetes planiceps* of the Pictou coal,* and from the remarkable footprints of *Sauropus Sydnensis*† and *Sauropus unguifer*.‡ It is to be observed also that as some of the amphibian animals found in the erect trees are represented only by single specimens, there may have been still rarer species, which may be discovered should other trees be exposed. Nor must we forget that the fauna of those swamps and low-lying plains of the carboniferous period, to which our knowledge is at present limited, may not fully represent that of the uplands of the period.

With reference to the probability of the discovery of additional remains in the beds to which this paper relates, I may state that new trees will no doubt be exposed from time to time by the gradual wasting of the cliff. Otherwise additional specimens can be procured only by regular mining operations carried on in the 6-inch coal and its roof. These would of course be costly, and the small amount of coal afforded by the 6-inch seam would contribute very little towards defraying the expense.

* Journal of Geological Society, vols. x. and xi.; 'Air-breathers of the Coal Period;' 'Acad. Geology,' p. 359.

† 'Acadian Geology,' p. 358.

‡ 'Geological Magazine,' vol. ix.

(Received March 8, 1882.)

Note I.—On Horny Scales and other Appendages of Carboniferous Amphibians.

I have discussed these at some length in my 'Air-breathers of the Coal Period,' and as few new facts occurred in the more recent explorations, I have merely adverted to them in the text. It has however been suggested to me that some more detailed reference to them would be desirable.

I have referred to this kind of cuticular covering as being found in connexion with the bones of *Hylonomus Lyelli* and *Dendrerpeton Acadianum* and *D. Oweni*. It may have been present in other species, but of course was likely to be preserved only in rare instances. The examples figured in Plates 40 and 45 may serve to give an idea of the perfect manner in which it has sometimes retained its characters, though unfortunately, from the uneven and irregular surface of the deposits in the interior of erect trees, it is always folded and crushed, so that it does not retain its original form.

It is to be observed that in the species referred to, the thorax and abdomen were protected with bony plates and scales. The horny scales and plates seem to have been confined to the upper parts.

The horny scales and appendages are entirely different in appearance from the bony plates and scales. The latter are usually white or gray in colour, and present under the microscope true bony structures. The former are black, shining, and coaly in appearance, and are inseparable from the cuticle along with which they are preserved. The ordinary horny scales are semicircular, imbricated, or scattered sparsely over the surface of the skin. They are of different sizes, and the larger often show minute round pores, probably mucous or perspiratory pores. These scales are most conspicuous toward the upper and anterior parts of the body. Elsewhere they often degenerate into microscopic tubercles implanted in the skin. Along the sides, and perhaps near the margin of the upper scaly portion of the skin, there are in some specimens larger angular scales, apparently free at the margins, and forming a sort of Vandyke edging. In front the skin projects into long pendant lappets, terminated by similar angular points, and covered with oval scales, not imbricated, and each having a pore in its centre. These appear to have been present both in *Dendrerpeton* and *Hylonomus*. In the latter, as stated in the text, there were on the back and shoulders thick ridge-like and conical tubercles, having their surfaces sculptured with furrows, and *H. Lyelli* has two rows of flat horny bristle-like processes forming frills or epaulettes.

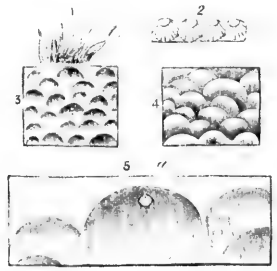
Portions of the scaly cuticle when carefully separated from the stone and mounted in balsam, are sometimes sufficiently thin to be studied as transparent objects. Viewed in this way, under a moderate power, the skin appears of a rich brown colour, and presents an areolar or cellular aspect, the scales appear dark brown, becoming

black at their distal edges, and their pores appear as round transparent spots; viewed as an opaque object, the scaly skin appears black and shining, and the edges of the scales seem to be very thin and to bend upward as if free from the skin. The bristle-like appendages of *Hylonomus* are also translucent, when mounted in balsam; but even under a high power show only a faint indication of longitudinal fibrous structure (see woodcut, figs. 1 to 5). The thicker plates, when sliced, show, near the base, a few curved canals, probably vascular, but the upper part appears quite compact, and under a high power merely shows faint indications of tortuous fibres or tubes. Even the thickest show no bony structures whatever, and have throughout a carbonaceous or bituminous appearance.

When burned, the cuticle and horny scales give a strong flame, and emit a bituminous and ammoniacal odour, their chemical characters being those of highly bituminous coal or jet.

These portions of cuticle and horny scales are of rare occurrence, and appear to have owed their preservation to being embedded in wet fragments of bark and other vegetable matter, perhaps possessing a tanning quality; small loose bodies of similar character have been found which may have been horny plates detached from the skin by decay, but it is impossible to say to what they belonged. One of these is a semi-circular plate, about half an inch in diameter, and studded with conical tubercles. It may have been the armature of the snout of one of the *Microsauria*.

For additional descriptions and illustrations, see 'Air-breathers of the Coal Period,' p. 34, and Plates 1, 4 and 5; and 'Acadian Geology,' pp. 369–373.



Scales and Appendages of *Hylonomus* and *Dendrerpeton*.

Fig. 1. Ornamental horny processes of *Hylonomus Lyelli*, × 10.
" 2. Horny tubercles of the same, × 10.
" 3. Cuticle and scales of *Dendrerpeton* (transparent), × 10.
" 4. The same (opaque), × 10.
" 5. Portion of the same, × 50, showing cutaneous pore at (*a*).

(Received April 10, 1882.)

I have much pleasure in appending the following note, which I consider a most important addition to my paper, showing that two species of Scorpions have been entombed with the other tenants of the erect trees.

Note II.—On Additional Remains of Articulates obtained by Dr. DAWSON *from Sigillarian Stumps in the Coal-field of Nova Scotia.** *By* Dr. SAMUEL H. SCUDDER.

The fragments sent to me for study, like those formerly received, consist in great part of myriapodal remains, often of single segments, and generally in a more or less crushed and flattened condition. In this respect they are not so well preserved as some of those previously studied, and obtained from erect trees in the same locality. Although all the species formerly separated occur in this collection, very little can be added to the statements then made. Two specimens occur of *Xylobius sigillariæ*, five of *X. similis;* three are somewhat doubtfully referred to *X. fractus*, eight to *X. Dawsoni*, and ten to *Archiulus xylobioides*. A single specimen of *X. Dawsoni*, showing four or five continuous segments, seems to prove that the elevated transverse ridge on each segment in this species was crowned by a single series of minute warts or raised points, not very closely set. A few specimens of different species exhibit the marks which were formerly interpreted as *foramina repugnatoria*, but are now presumed to be the casts of bases of spines,† thus bringing these species into more definite and probable relations to the carboniferous myriapods of Mazon Creek, though they plainly belong to a distinct group. Whatever spines they had must have been very small, slight, and wholly insignificant in comparison with those of the bristling *Archipolypoda* of the Morris beds. Careful search has been made for any other of those special features which distinguish the *Archipolypoda* from recent *Diplopoda*, but in vain, beyond the single but not unimportant point that the ventral plates, in *Archiulus* at least, are very broad and probably almost equally extensive in lateral expansion with the dorsal plates, a feature found nowhere in modern *Diplopoda*.

This is, perhaps, most clearly shown in two new species of *Archiulus*, discovered among these remains, and to which are referred a dozen or more specimens. One of these species is of about the same size with *A. xylobioides*, but has perfectly flat segments showing only a very slight and narrow transverse ridge at the anterior margin, occupying not more than one-fourth of the segment. The other is a smaller species, and has shorter and more simple segments, made slightly concave by the

* For descriptions of the remains previously discovered, see Mem. Bost. Soc. Nat. Hist., vol. ii., pp. 231–239, 561–562 (1873, 1876).

† Mem. Bost. Soc. Nat. Hist., vol. iii., pp. 148, 149 (1882).

gentle elevation of both front and hind margins, but with no anterior ridge. In neither of these species could any trace of spines be found.

Besides the myriopodal remains, there are a dozen fragments that must probably be referred to Scorpions. Of some of them there can be no doubt. The remainder are mere bits of integument showing the surface sculpture, but often with no natural borders whatever. In the character of the surface there is such difference as to indicate more than a single species. For though we should certainly expect to find considerable differences between the various parts of one and the same individual, the diversity here is too great, both in amount and nature, to render it at all probable that the difference may fairly be explained in such a manner. The better fragments exhibit a considerable portion of the stouter part of the body, enough to show its general form at least, and these point also to the probable existence of two species, of nearly the same size, but differing in form and sculpture; the more fusiform-shaped species having a less roughened surface than is found in the more parallel-sided form. The latter agrees tolerably with the carboniferous genus found near Mazon, Ill., called *Mazonia* by MEEK and WORTHEN, and certainly belongs to the same group of Scorpions; but in view of the remarkable addition to our knowledge of the carboniferous Scorpions in the promised publication of the researches of Mr. PEACH of the geological survey of Scotland, further study of these remains will best be postponed. In the meantime, they add another form of strictly land life to those already found in these remarkable repositories of fossils, and perhaps illustrate the utility of the bony and horny armour of the smaller Batrachians of the period, which may have had to contend with these active and venomous Arachnidans.

The occurrence of seven species of Millipedes in a few decayed trees in one locality, in connexion with similar discoveries in other parts of the world, tends to strengthen the probability of the suggestion, already made by Dr. DAWSON, that the animals of this type may have culminated in the Palæozoic period.

(Received September 4, 1882.)

Note III.—On the Footprints of Batrachians observed in the Carboniferous Rocks of Nova Scotia.

Though it is impossible to identify with certainty the footprints of particular species of the Batrachians of the coal-formation, and though most of the animals which have left impressions of this kind are much larger than those found in the erect trees, yet to give completeness to this memoir, it may be well to notice the indications of this kind which have been observed; more especially as they have not previously been brought together into one view.

For convenience, I shall refer the larger footprints, probably those of Labyrinthodonts of considerable dimensions, to the genus *Sauropus*, already established by Lea, and the smaller impressions, due perhaps to smaller Labyrinthodonts or to Microsaurians, and usually showing a longer stride and more slender toes, to the genus *Hylopus*. Besides these, there are the curious trails named *Diplichnites*,* and which may have been made by large unknown serpentiform batrachians.

Impressions of both types first appear in the lowest carboniferous or Horton series, corresponding to the "Tweedian series" of Tate, the "calciferous sandstones" of McLaren, and the carboniferous slate and Coomhala grit of Jukes. No bones of Batrachians have as yet been found in these beds, but the footprints indicate the presence at the beginning of the Carboniferous Period, and before the deposition of the lower carboniferous limestones, of both large and small species similar to those of the coal-formation. At the other extremity of the carboniferous system, footprints have been found on the sandstones of the upper coal-formation or permo-carboniferous series.

1. *Sauropus unguifer*, Dawson.

[Geological Magazine, vol. ix. 'Acadian Geology,' 3rd edition, supplement, p. 62.]

This is the largest footprint yet found in the coal-formation of Nova Scotia. The length of the hind-foot, on one of the slabs having the largest and most distinct impressions,† is six inches, and its greatest breadth about five inches; the stride is from 12 to 13 inches, the distance of the two rows of tracks being about seven inches, and the hind-foot covering the impression of the fore-foot, which from other slabs would appear to have been smaller and shorter. The impressions show four ordinary toes, and a fifth outer toe armed with a long claw or spur, which sometimes trailed on the ground, and, when the foot was planted, was plunged into the mud. It was no doubt an aid to the animal in ascending inclined surfaces of mud.

* Am. Journal of Science, 1873.

† Collected by Sandford Fleming, Esq., C.E., and now in the Museum of the Geological Survey.

Very fine series of footprints of several individuals of different sizes, and showing different gaits, and in one instance the act of wallowing in soft mud, have been found in sandstone at Fillmore's Quarry, River Philip, Nova Scotia, and are now in the Museum of the Geological Survey. In some of the series of tracks there is no mark of the belly or tail. In others the belly has left impressions marked with longitudinal grooves, as if there were abdominal furrows or rows of scales. Descriptions of the principal specimens will be found in the publications above referred to.

2. *Sauropus Sydnensis*, Dawson.

['Acadian Geology,' 3rd edition, p. 358, and woodcut.]

This animal had shorter and broader feet, with five toes and no indication of the peculiar claw of the previous species. The breadth of the foot was about three inches, the width of the body about six inches, and the stride about eight inches. The original specimen was obtained by R. Brown, Esq., F.G.S., in the coal formations at Sydney, Cape Breton, and is now in the Museum of the McGill University.

Sauropus antiquior, Dawson.

This species is based upon a series of footprints found by Mr. F. M. Jones, of Halifax, at Parrsboro, and now I believe in the Provincial Museum at Halifax, where I have seen the specimen. The horizon is probably that of the Horton series. The footprint is about three and a-half inches wide, and scarcely half as much in apparent length. It shows four subequal toes, and an outer toe diverging from the others, and showing indications of a short claw. The shortness of the impressions in this species and in *S. Sydnensis* gives them a digitigrade aspect, while those of *S. unguifer* have a plantigrade appearance, varying however in different impressions.

Hylopus Logani, Dawson.

['Air-breathers of the Coal Period,' p. 5, fig. 1. 'Acadian Geology, 3rd edition, p. 353.]

The original specimen of this footprint was found by Sir W. E. Logan at Horton Bluff in 1841, and was the first evidence of the existence of Batrachians in the Carboniferous Period. The specimen obtained by Logan is fully described in the works above cited. The impression has been made on a firm surface, and shows merely the marks of four claws or narrow toes. Each impression is about one inch in length; the distance between the right and left footmarks is about three inches, and the stride about four inches. There is no mark of the belly or tail. In 1881 a somewhat larger series of impressions, which should, however, probably be referred to the same species, was found in the same beds by Mr. Pineo, of Hantsport, and is now in the Museum of

the McGILL University. It shows indications of a fifth toe; and while the length of the foot is less than two inches, the stride is about eight inches, or more than four times the length of the foot.

5. *Hylopus Hardingi*, DAWSON.

['Air-breathers of the Coal Period,' fig. 2, 'Acadian Geology,' 3rd edition, p. 356, fig. 139.]

This specimen, discovered by the late Dr. HARDING, of Windsor, in the lower carboniferous shales of Parrsboro, indicates an animal of about the same size with *H. Logani*, and possibly nearly allied to it, but with five distinct and subequal toes which are long and slender. The footprints are about an inch in length, and those of the fore and hind feet are separate and of about equal size and similar form. The most remarkable feature of this series is the great length of the stride, which is nearly five times the length of the foot, and twice as much as the distance between the rows of tracks, apparently indicating that the animal stood as high on its legs as an ordinary Mammal.

6. *Hylopus Caudifer*, DAWSON.

['Air-breathers of the Coal Period,' fig. 3.]

This is a slab with a series of footprints less than an inch in length and five-toed. The rows are distant from each other three inches and a-quarter, and the stride is three inches. There are at intervals marks of a tail trailed behind. This impression is in my own collection, and is from the middle coal-formation of the South Joggins, on gray ripple-marked sandstone.

In addition to the above, many obscure impressions have been found, which no doubt indicate several additional species. It is observable that in all the members of the carboniferous series, these footprints have been found most plentifully in the vicinity of those old ridges of land based on the older formations, which as I have shown in my 'Acadian Geology,' traversed the areas of deposition in Nova Scotia in the Carboniferous Period. On these isolated patches of land the Batrachians may have continued to exist throughout the period, undisturbed by the oscillations of elevation and depression which affected the lower levels.

It is evident that the smaller footprints to which I have referred under the generic name *Hylopus*, may have been produced by animals akin to those whose remains are found in the erect trees, though of somewhat larger dimensions; and it is instructive to observe that at the beginning of the Carboniferous Period there must have existed animals of this kind comparable in development of limb with the most highly endowed in this way of the *Microsauria*, and of greater bulk than those whose bones are found in the erect trees.

If we inquire as to the footprints of larger size included in the genus *Sauropus*, we know by the evidence of osseous remains that some large Batrachians inhabited the areas of coal deposition in Nova Scotia. More especially *Baphetes planiceps* (Owen) must have been an animal of sufficient dimensions to have produced footprints like those of *Sauropus unguifer*. A second species of *Baphetes* is probably indicated by a jaw-bone found at the South Joggins, and which I have named provisionally *B. minor*. The *Eosaurus Acadianus* of Marsh must have been a large animal; but we do not yet know if it was capable of walking on the land.

On the whole, the evidence of footprints serves to indicate that both *Labyrinthodontia* and *Microsauria* existed in Nova Scotia throughout the Carboniferous Period, and that very many of the larger and important species still remain to be discovered. It seems remarkable that, while remains of Fishes are so abundant in the carboniferous shales of Nova Scotia and New Brunswick, nothing is as yet known as to the more aquatic types of Batrachians found so abundantly in the carboniferous strata elsewhere. This may either indicate a local paucity of these creatures, or may be a mere accident of preservation or discovery.

Explanation of the Plates.

(Figures not otherwise designated are of the natural size.)

PLATE 39.

Hylonomus Lyelli (figs. 1 to 14).

Fig. 1*. Skull and portion of skeleton.

Fig. 2*. Skull of the same. × 2.

Fig. 3*. Skeleton. (*a*) Fore limb. (*b*) Vertebræ and ribs, the former with bony coating stripped off and showing hourglass-shaped casts of interior. (*c*) Femur. (*d*) Pelvis. (*e*) Remains of femur and tibia.

Fig. 4. Section of tooth. × 500.

Fig. 5. Cells of bone. × 500.

Fig. 6. Portion of maxilla with teeth.

Fig. 7. Teeth. × 25.

Fig. 8. Mandible and teeth.

Fig. 9. Maxilla. × 5.

Fig. 10. Bones of foot.

* Figures marked with an asterisk are from drawings by J. H. Emerton. The remainder are from photographs by Inglis and camera drawings by the author.

Fig. 11. Rib.

Fig. 12. Skull, crushed laterally. (*o*) Orbit. (*m*) Mandible. (*n*) Nasal bones.

Fig. 13. Skeleton, showing portions of limbs, vertebræ and ribs.

Fig. 14. Femur and thoracic plate.

Hylonomus Wymani (figs. 15 to 17).

Fig. 15. Mandible. × 8.

Fig. 16. Teeth. × 25.

Fig. 17. Vertebra. × 5.

Hylonomus latidens (figs. 18 to 22).

Fig. 18. Teeth. × 25.

Fig. 19. Section of jaw and teeth. × 5.

Fig. 20. Vertebra. × 2.

Fig. 21. Fragment of humerus. × 2.

Fig. 22. Mandible with teeth. × 5.

Hylonomus multidens (figs. 23 to 26).

Fig. 23. Mandible, maxilla, and cranial bones. × 3.

Fig. 24. Outline of another skull. × 2.

Fig. 25. Teeth. × 25.

Fig. 26. End of femur. × 2.

Hylonomus Lyelli (fig. 27).

Fig. 27. Diagram showing probable arrangement of ornamental horny scales (enlarged). (*a*) Horny scales enlarged. (*b*) Bony scales, natural size and magnified.

PLATE 40.

Smilerpeton aciedentatum (figs. 28 to 45).

Fig. 28. Section of tooth. × 500.

Fig. 29. Cells of bone. × 500.

Fig. 30. Teeth, lateral aspect. × 25.

Fig 31. Teeth, longitudinal aspect. × 25.

Fig. 32. Section of tooth. × 50.

Fig. 33. Shaft of femur? × 2.

Fig. 34. Intermaxillary and teeth. × 25.

Fig. 35. Sections of teeth. × 25.

Figs. 36, 37. Palatal teeth. × 25.

Fig. 38. Mandible. × 2.

Fig. 39. Large palatal teeth. × 25.

Fig. 40. Fragment of femur. × 2.

Fig. 41. Rib. × 2.

Fig. 42. Palate. × 2.
Fig. 43. Caudal vertebra.
Fig. 44. Long palatal tooth. × 25.
Fig. 45. Bony scale. Natural size and magnified.

Dendrerpeton Acadianum (figs. 46 to 51).

Fig. 46*. Portion of cuticle, wrinkled and scaly. Fig. 46A. Lateral points. Fig. 47B. Lappets and pendants.
Fig. 47*. Ends of smaller pendants. Magnified.
Fig. 48*. Pendant. × 2.
Fig. 49*. Two points and scaly surface. × 4.
Fig. 50. Scaly surface. × 5.
Fig. 51. Pendant. × 2.

Sparodus, sp. (figs. 52 to 56).

Fig. 52. Tooth. × 25.
Fig. 53. Four of the smaller teeth. × 25.
Fig. 54. Three bony scales. × 5.
Fig. 55. Fragment of limb bone. × 2.
Fig. 56. Vertebra. × 2.

Amblyodon, sp. (figs. 57 to 61).

Fig. 57. Tooth. × 25.
Fig. 58. Section of tooth. × 5. Fig. 58A. Same. × 25.
Fig. 59. Fragment of thoracic plate.
Fig. 60. Shaft of limb bone.
Fig. 61. Rib.

PLATE 41.

Hylerpeton Dawsoni (figs. 62 to 85).

Fig. 62*. Section of palate with teeth. Fig. 62A. Same. × 2.
Fig. 63*. Section of large tusk. Fig. 63A. Same. × 2.
Fig. 64*. Mandible and teeth. Fig. 64A. Same. × 2.
Fig. 65*. Vertebra. End view.
Fig. 66*. Fragment of rib?
Fig. 67*. Femur.
Fig. 68*. Humerus and vertebra.
Fig. 69*. Head of humerus.
Fig. 70*. Rib.
Fig. 71. Scales.
Fig. 72. Large scale.
Fig. 73. Bones of foot.
Fig. 74. Tooth. × 25.

Fig. 75. Dentine of tooth. × 500.
Fig. 76. Cell of bone. × 500.
Fig. 77. Scales. × 2.
Fig. 78. Head of rib.
Fig. 79. Rib.
Fig. 80. Tooth, showing ribbed interior and smooth surface.
Fig. 81. Fragment of vertebra. × 2.
Fig. 82. Section of body of vertebra. × 2.
Fig. 83. Section of tooth. × 50.
Fig. 84. Fragment of humerus—ribs and scales.
Fig. 85. Mandible of a small specimen. × 5.

PLATE 42.

Hylerpeton longidentatum (figs. 86 to 109).

Fig. 86*, 87*. Mandible and teeth. 86A. Same. × 2.
Fig. 88*. Fragment of palate with teeth. 88A. Same. × 2.
Fig. 89*. Thoracic armour.
Fig. 90*. Fragments of limb bones (these possibly belong to next species).
Fig. 91*. Limb bone and rib.
Figs. 92*, 93*, 94*. Vertebræ.
Fig. 95*. Fragment of scale.
Fig. 96. Section of tooth. × 500.
Fig. 97. Tooth. × 25.
Figs. 98, 99. Teeth showing grooved points. × 25.
Fig. 100. Cross section of tooth. × 25.
Fig. 101. Scale. × 2.
Fig. 102. Head of rib. × 2.
Figs. 103, 104. Palatal teeth. × 25.
Fig. 105. Limb bones. × 2.
Fig. 106. Cells of bone. × 500.
Fig. 107. Rib.
Fig. 108. Teeth and mandible. × 8.
Fig. 109. Mandible and thoracic plate. × 2.

PLATE 43.

Fritschia curtidentata (figs. 110 to 128).

Fig. 110*. Portion of mandible. Fig. 110A. Same. × 2.
Fig. 111*. Maxilla and teeth. Fig. 111A. Same. × 2.

Fig. 112*. Humerus, ulna, and tarsal bone.
Fig. 113*. Femur, distal end.
Fig. 114*. Humerus?
Fig. 115*. Limb bones.
Fig. 116*. Rib and limb bones.
Fig. 117*. Vertebræ.
Fig. 118*. Portion of palate.
Fig. 119. Tooth, showing grooved point. × 25.
Fig. 120. Tooth. × 25.
Fig. 121. Section of tooth. × 500.
Fig. 122. Cells of bone. × 500.
Fig. 123. Bones of anterior limb.
Fig. 124. Ribs, vertebræ, and bony rods.
Fig. 125. Various bones. (*a*) Maxilla. (*b*) Humerus. (*c*) Bony rods. (*d*) Femur. (*e*) Rib.
Fig. 126. Vertebræ.
Fig. 127. Mandible, curved by pressure.
Fig. 128. Various bones. (*a*) Maxillary. (*b*) Humerus and limb bones.

PLATE 44.

Dendrerpeton Acadianum (figs. 129 to 130 and 132 to 137).
Fig. 129. Interior of skull and mandible.
Fig. 130. Maxilla. × 2.
Fig. 132. Plan of constituent bones of skull represented in fig. 129. (*N*) Nasals. (*F*) Frontals. (*SOr*) Super-orbitals. (*P*) Parietals. (*PP*) Post-parietals. (*Pt*) Pterotics. (*SOc*) Super-occipitals. (*E*) Epiotic.
Fig. 133. Section of tooth. × 250.
Fig. 134. Cells of bone. × 500.
Fig. 135. Tooth. × 25. Showing plaited surface.
Fig. 136. Fragments of super-orbital and parietal, showing sculpture. × 5.
Fig. 137. Five teeth. × 5.
Dendrerpeton Oweni (figs. 131, 138, 139).
Fig. 131. Maxillary, showing sculpture and teeth. × 2.
Fig. 138. Teeth. × 25.
Fig. 139. Foot. × 2.

PLATE 45.

Hylonomus Lyelli.

Fig. 140. Skin and horny plates, tubercles, and scales of this species; from a micro-photograph. × 5. The specimen represents a fragment from the shoulder.

Erect Trees.

Fig 141. Tree No. 13, as standing in the reef; from a photograph by T. C. Weston, Esq., of the Geological Survey of Canada.

PLATE 46.

View of Coal-mine Point, South Joggins, Nova Scotia; from a photograph by J. C. Weston, Esq.

PLATE 47.

Plan of Low-tide Beach off Coal-mine Point, and section to illustrate the position of the trees containing remains of land animals, by W. B. Dawson, M.A., Assoc. Mem. Inst. C.E.

HYLONOMUS

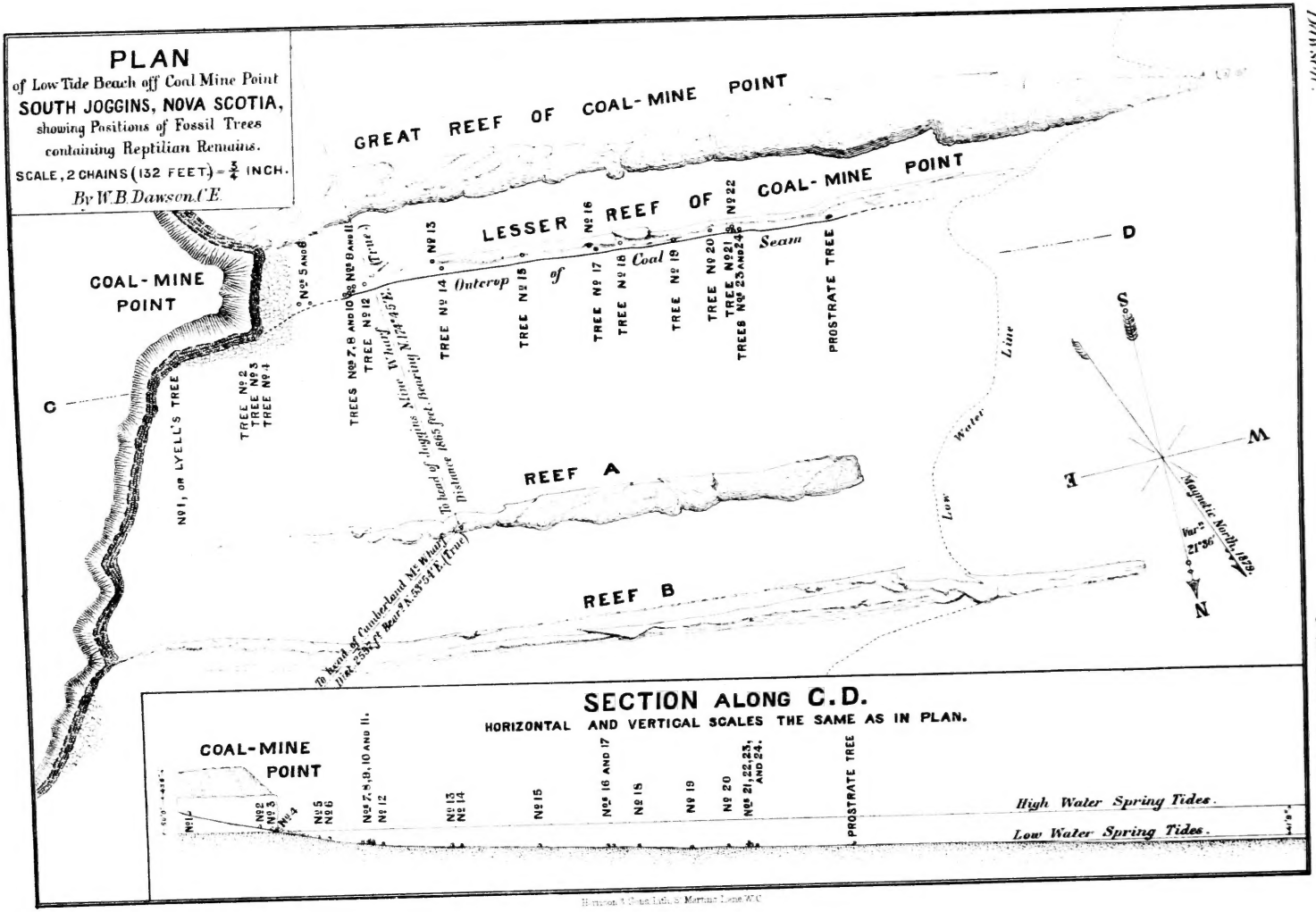
West Newman & Co. imp.

SMILERPETON (28 to 45) DENDRERPETON (46 to 51) SPARODUS (52 to 56) AMBLYODON (57 to 61)

HORNY ARMOUR OF BACK OF HYLONOMUS.

West Newman & Co. imp.

COAL MINE POINT, S. JOGGINS, 1879.



Hanson & Co's Lith. 6 Martins Lane W.C.